Testing of ^{6}Li Glass Scintillator for Detection of Fission Neutrons Below 1 MeV

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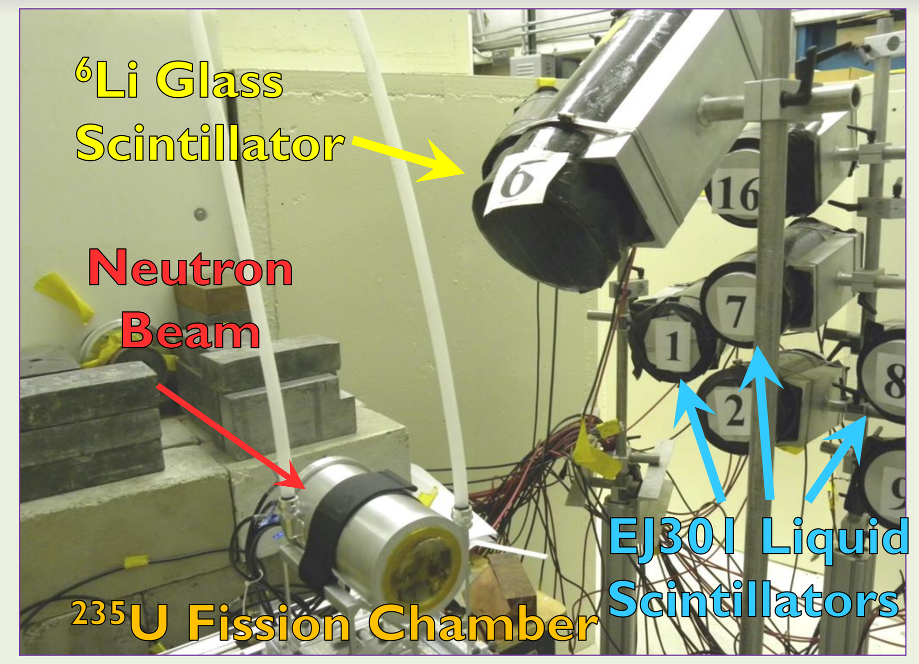
I. Abstract

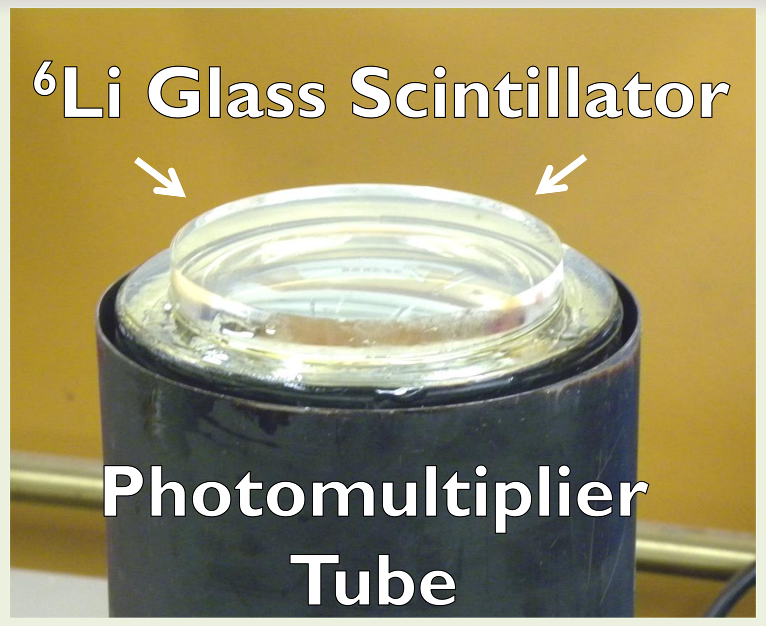
^{6}Li glass scintillator detectors are being tested and integrated into the Chi-Nu apparatus at LANSCE/WNR. Chi-Nu is an array of neutron detectors used for detecting neutrons in neutron-induced fission experiments. ^{6}Li glass scintillators have better detection efficiency in the neutron-energy range below 1MeV than currently used EJ301 liquid scintillators. Various reflectors are being tested to determine which optimizes the performance by increasing detected scintillation light. Increasing the thickness of the scintillator is also being studied to optimize detection efficiency at 1MeV. Calibrations using several sources verify the expected detection peak at 4.8MeV.

II. Chi-Nu / FIGARO Apparatus

- Fast-neutron Induced GAmma Ray Observer.
- An array of 20 scintillator neutron detectors.
- Measures Incident and Fission Neutron Energies by Double Time-of-Flight.
- Uses coincidence of fission and detected neutron.



III. ^{6}Li Detector



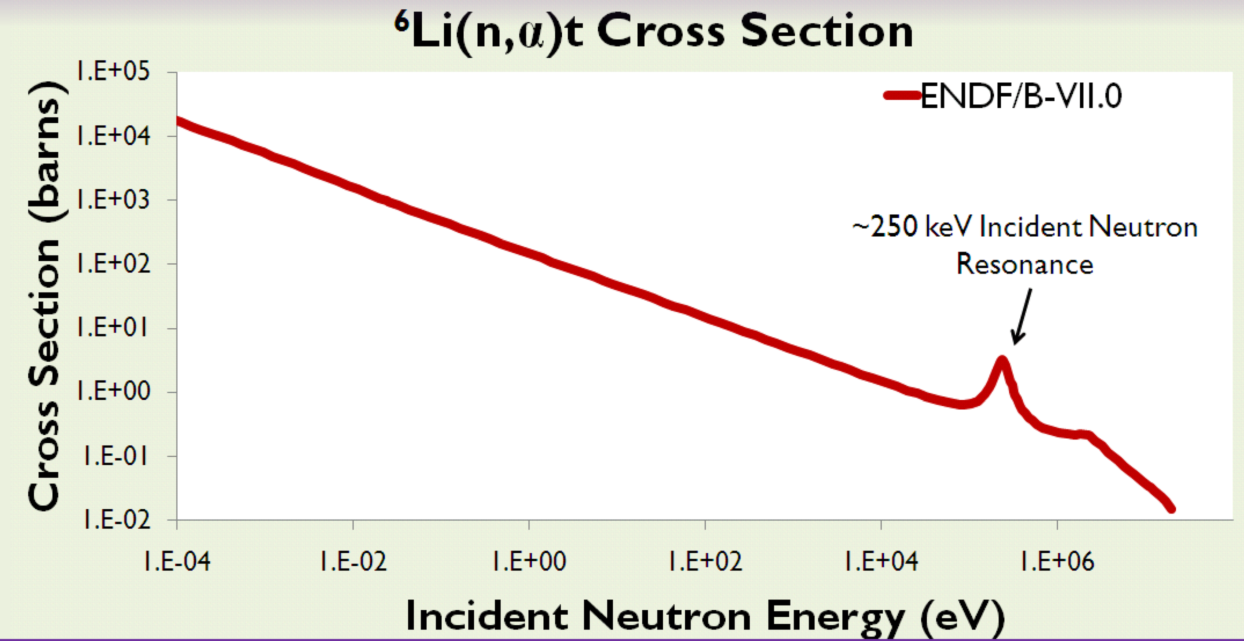
- Detects neutron from exothermal reaction:

$$^6\text{Li} + n \rightarrow {}^4\text{He} + {}^3\text{H} + 4.8\text{MeV}$$

- Kinetic energy of the charged particles, ^{4}He + ^{3}H, is converted into scintillation light.
- Light is converted into an electronic signal by a photo-multiplier tube.

IV. Efficiency

- Efficiency decreases for E_n>1MeV, with resonance at ~250 keV.
- Increase thickness of scintillators to improve efficiency near 1MeV.
- Also risk increasing background due to γ-ray Compton scattering.

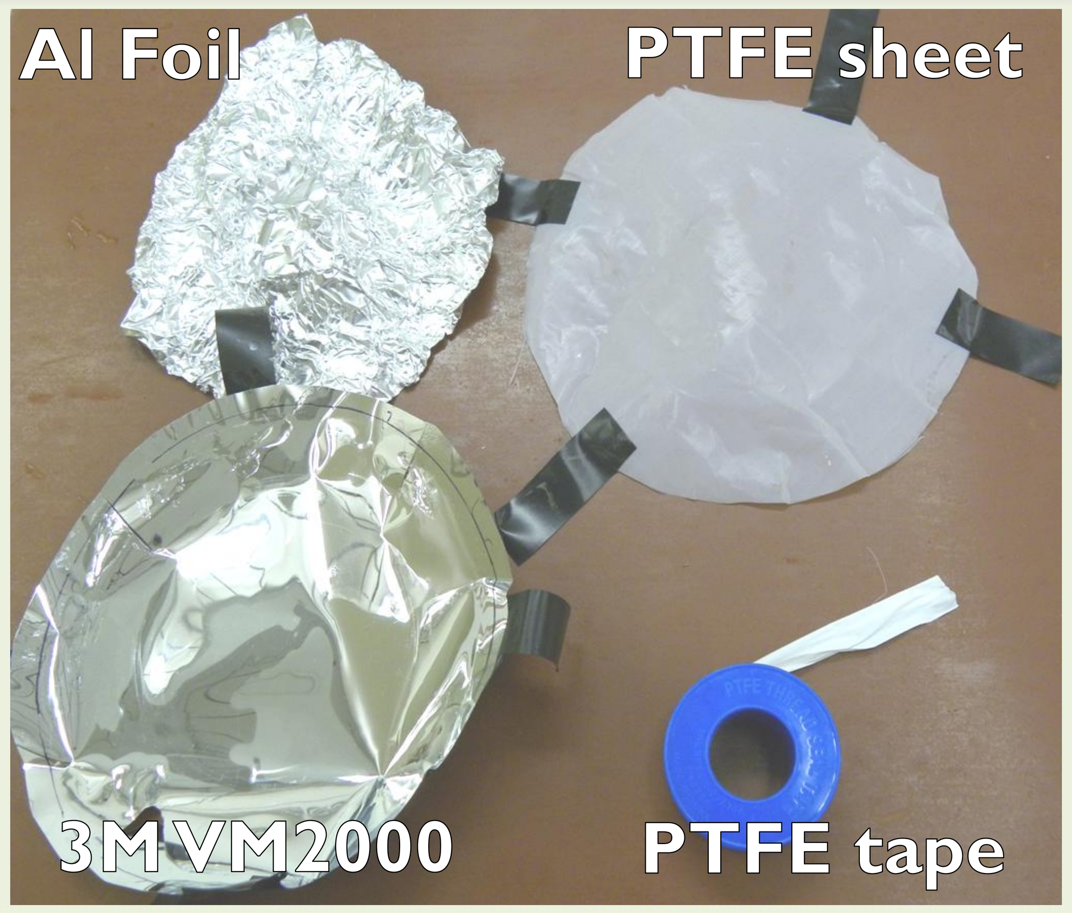


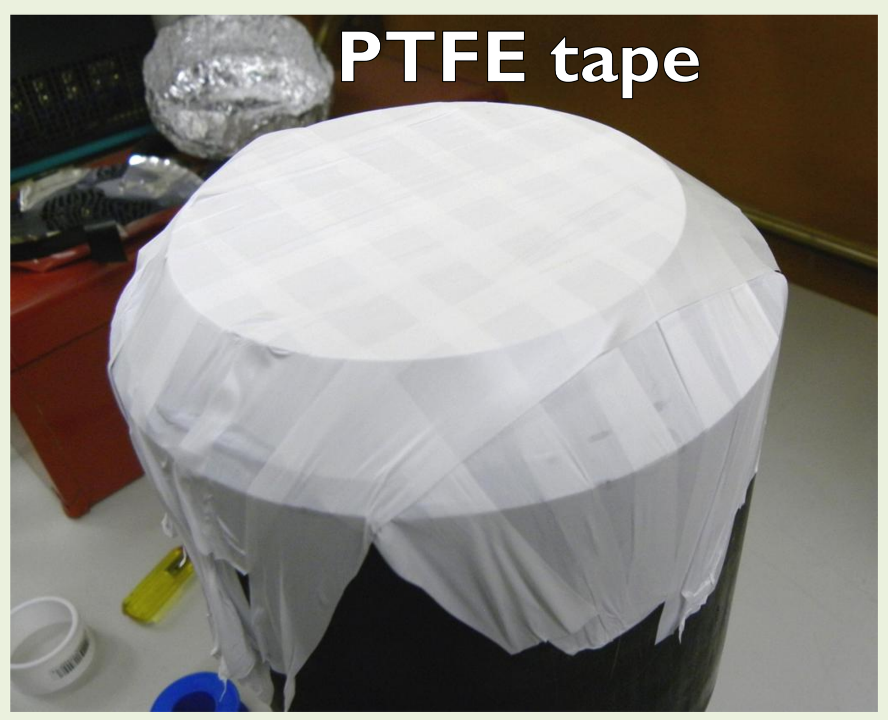
V. Reflectors

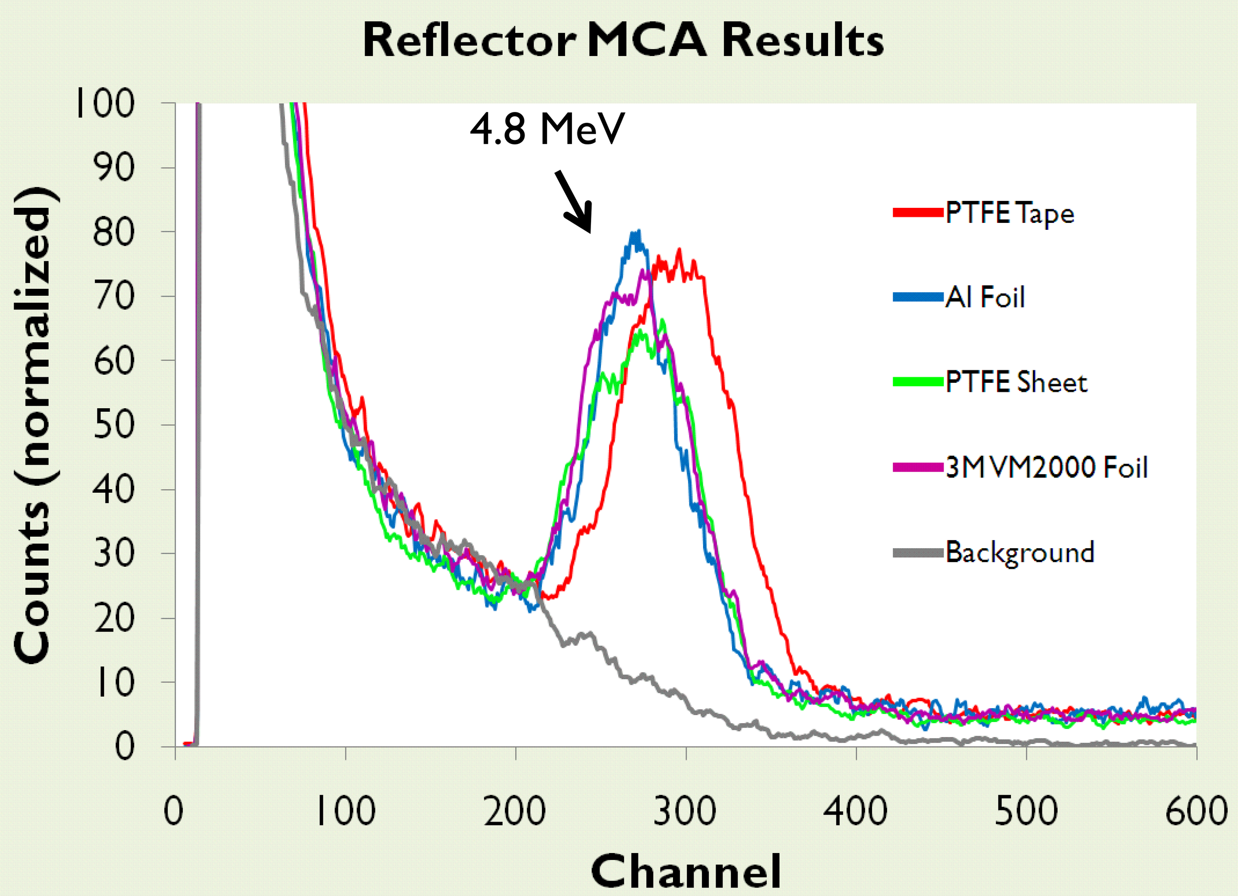
- Goal is to increase detected scintillation light.
- Reflectors cover scintillator to reflect scintillation light into photo-multiplier tube.

Currently testing:
- Aluminum Foil
- PTFE (Teflon™) Tape
- PTFE (Teflon™) Sheet
- 3M VM2000 Polymeric Film: 99+% reflective

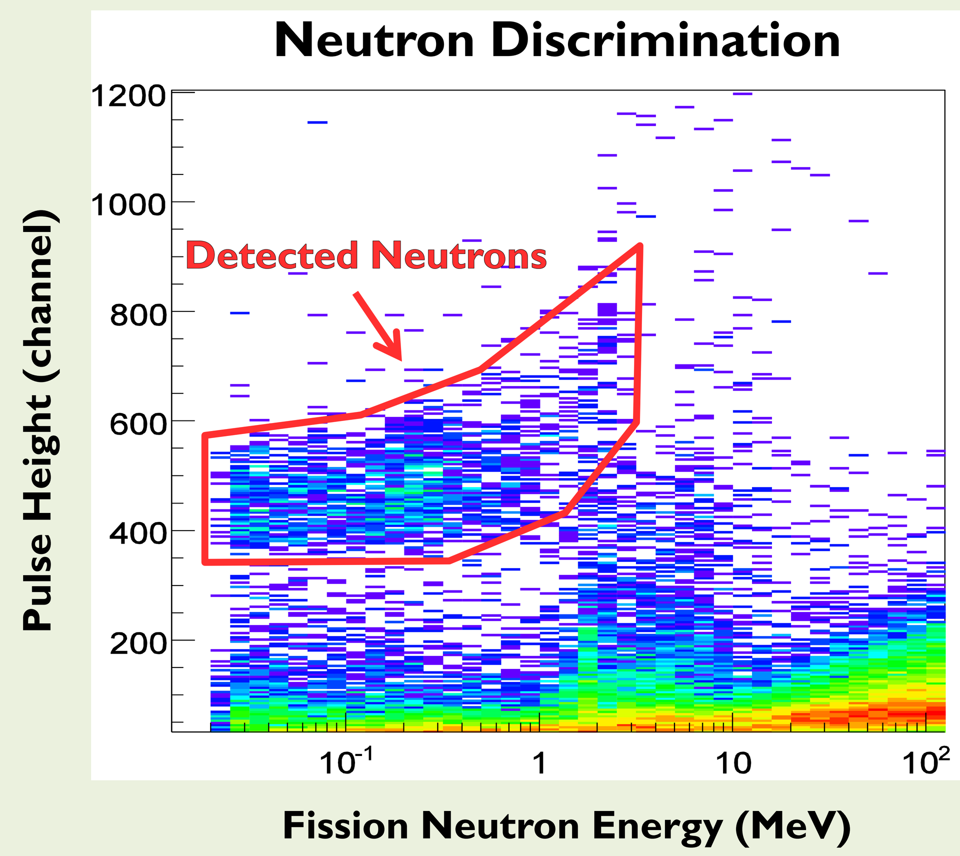
Results:
- Best reflector is PTFE (Teflon™) Tape by ~10%
- 4.8MeV peak is on higher channel, meaning better energy resolution.



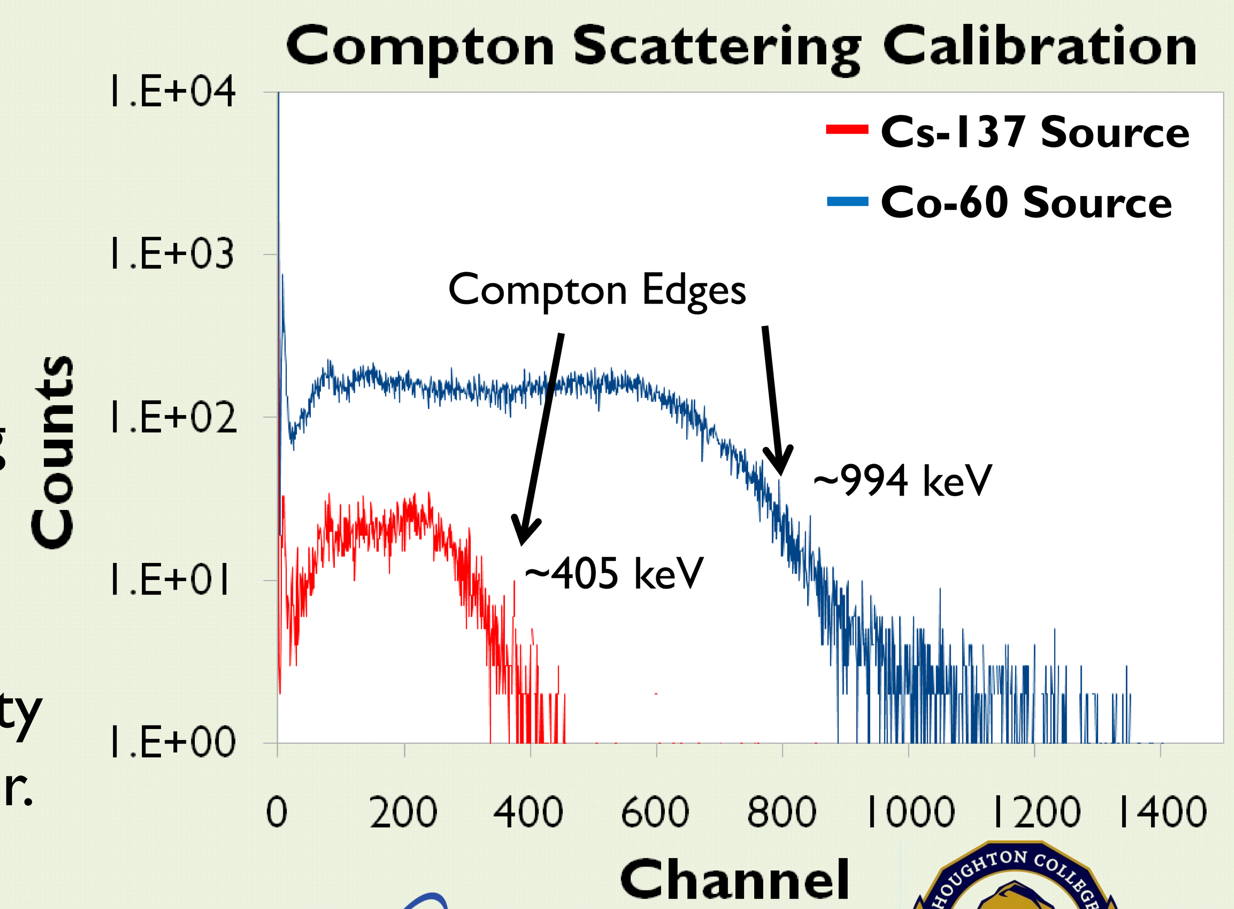




VI. Calibrations



- Gate Pulse Height vs. E_n to identify neutrons.
- Use ^{137}Cs and ^{60}Co γ-sources to calibrate Energy Spectrum using Compton Edge.
- For γ-rays where $h\nu >> mc^2/2$: Energy difference between edge and actual γ-ray energy = ~0.256 MeV.
- Channels are linearly proportional to Energy.



VII. Conclusions

- Data from ^{6}Li scintillator are meeting expectations.
- PTFE tape is best reflector due to its diffuse reflective properties and ability to tightly wrap around the scintillator.
- Increasing thickness of scintillator increases efficiency near 1MeV, but also increases background.